

**HANDWRITING USER INTERFACE FOR
PERSONAL DIGITAL ASSISTANTS AND THE LIKE**

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 The present invention is related to personal digital assistants (PDAs) and more particularly to a user input interface for a PDA or the like.

BACKGROUND DESCRIPTION

10 Portable computing devices, such as what is normally referred to as a personal digital assistant (PDA), are increasing in popularity. A typical PDA is a limited function microcomputer provided with a pressure sensitive liquid crystal diode (LCD) display (a touch pad or a touch screen) for input and output (I/O). PDAs are being adapted for wireless Internet communication, e.g., using a modem for e-mail and web browsing. Further, for text input PDAs are known that have a specialized stroke based alphabet interface, e.g., Graffiti®, a selectable on-screen QWERTY keypad, or
15 an expansion pack keyboard.

 As these portable devices become smaller and more specialized, text input has become more difficult and less practical. Typical prior art handwriting recognition software may require users to learn special characters or effect a handwriting style in order to enter text. Text input using the Graffiti® unistroke (i.e., written with a single
20 pen trace) alphabet can be un-natural because it requires users to adhere to strict rules

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that restrict character shapes; text input using an on-screen QWERTY keypad is somewhat clumsy because only small reductions in size can be made to keyboards before they become awkward to use. An expansion keyboard is impractical for on-the-go input. With either, the tapping on individual characters or the typing is less
5 desirable than being able to handwrite notes or messages. Meanwhile, the demand for PDA information exchange, e-mail and internet access requires entry and retrieval of increasing amounts of data with the handheld device.

Natural handwriting recognition (HWR) programs have been developed to add to function and usefulness to PDAs and are crucial to the growth of mobile computing
10 in the communications field. To use such handwriting recognition software, such as Transcriber (formerly known as Calligrapher) from Microsoft Corporation, the user is allowed to write a message anywhere on the screen, i.e., on top of any displayed application and system elements. Once the text is corrected, it may be embedded in the e-mail message, for instance, and, the next sentence or string of words can be
15 entered. However, typically, correction is deferred until the message or word storing is completed, when the whole string may be displayed, because during input the entire display is used for handwriting input.

However, these write anywhere approaches require a special mechanism to distinguish pen movement events that correspond to handwriting input from pen
20 events that are intended to manipulate user interface elements such as buttons, scroll bars and menus. Often it is difficult to differentiate between these two modes of stylus operation, viz. that of a writing implement for text entry (inking mode) and its control function such as for clicking on application icons and the like (control mode).

Another problem with a write-anywhere user interface is that fingers, as the writer is moving his/her hand through the screen, can often interfere with the (pressure-based) pen tracking mechanism. Simultaneous pressure from the stylus and a carelessly positioned pinky finger for instance can cause the device to mislocate the intended
 5 stylus entry point, e.g., the device may use the average of the two contact locations. These shortcomings can lead to text input errors and the attendant aggravation and input delays caused by such errors.

Typically, these state of the art handwriting recognition programs exhibit a top-n recognition accuracy of around 85% (top-1) and 95% (top-5), where top-n
 10 recognition accuracy is a measure of how often the correct answer is among the highest ranked n results. An 85% recognition accuracy, where one in six words is misrecognized, is not particularly tolerable for many users. However, at higher recognition rates of 95% and above, where only 1 in 20 words is misrecognized, users are more inclined to use handwriting recognition software. Therefore, easy access to
 15 recognition alternates -- i.e., top-n results, is a very important HWR feature.

An additional user interface issue with a write-anywhere text input paradigm is that there are usually no input method control elements visible anywhere on the screen. For instance, access to recognition alternates might require a special pen gesture. As such, a write-anywhere interface generally is not very appealing to less
 20 advanced users. Furthermore, recognition in the write-anywhere case is more difficult because there is no implicit information provided to the recognition engine regarding word separation, orientation, or size of the text.

Thus, there is a need for handwriting input user interface that easily distinguishes between control mode and inking mode of the pen, that allows easy access to recognition alternatives, and that enables accurate recognition of handwritten words.

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BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects and advantages will be better understood from the following detailed preferred embodiment description with reference to the drawings, in which:

Figure 1 shows a preferred embodiment handheld device with a graphical
10 handwriting user interface according to preferred embodiment of the present invention;

Figure 2 shows an example of the handwriting user interface (HUI) displaying a word correction keyboard for manually correcting a handwritten word;

Figure 3 is a flow diagram of an example of a method for implementing the
15 handwriting user interface of the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is a method of interfacing with and a handwriting user interface (HUI) for small (pocket-shirt sized) portable devices with a touch-enabled input/output (I/O) screen, such as are commonly known as personal digital assistants (PDAs). The portable devices may be capable of wireless message transmission (such as for web browsing and/or e-mail). The user interface of the present invention is typically in software and loaded into PDA storage. A state of the art handwriting recognition engine also is included in software. The handwriting user interface of the present invention enhances the usability, flexibility and power of the handheld device in which it is installed. An entire message may be quickly handwritten, converted, stored and then, transmitted, for example.

Figure 1 shows a preferred embodiment pocket sized handheld device 100 with a housing 101 graphical handwriting user interface 102 according to preferred embodiment of the present invention. A lower portion of the display is designated as a handwriting input area 104. In the illustrated and preferred form, the housing 101 has a compact pocket sized form with a rectangular configuration having dimensions on the order of 120 x80 mm with the screen height being 82 mm and the width being 62 mm, for example. Action icons 106, 108, 110, 112 and 114 are disposed at a right side of the handwriting user interface 102. Recognized text is displayed at the top of the screen under a file management tool bar 116. In this embodiment, a scroll bar 118 is disposed at the right side of the interface display 102. As each word is recognized, it is shown inserted into the text at the top of the interface display 102 and, a secondary list of potential recognition candidates may be displayed in a box 120 and

offered for substitution for or in lieu of the recognized word. Although the secondary word list box 120 is preferably displayed in the input area 104, in this example it is shown just above the handwriting input area 104.

Handwritten Entries are made at the designated input area 104 on the touch
5 screen, preferably of dimensions $0.30 \times H$ by W , where H and W are the height and width of the device screen. The preferred location of the input area is the bottom of the screen 102, so as to only partially block view of any application currently running on the device. Thus, only the stylus is above the input area 104 during entry with the largest portion of the hand resting on the housing 101 therebelow. Handwritten words
10 are entered into the input area 104 one word at a time using a stylus and, recognition results can be displayed in the same input area 104 or in the normal display area of the screen above the input area 104.

The device 100 may include a communications function and, to that end in this embodiment, an antenna 122 is shown at the top of the device 100. Individual
15 function switches, buttons and other controls are disposed about the device, as is deemed appropriate for the particular device. The device 100 may also include an expansion port 124 or an expansion port function may be provided wirelessly through antenna 122. Preferably, the device 100 runs under a state of the art operating system for such handheld devices, e.g. Windows® CE from Microsoft Corporation, Epoc®
20 from Symbian or the Palm OS® from Palm, Inc.

The preferred embodiment HUI of the present invention employs a handwriting recognition engine capable of recognizing handwritten words, written

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using any combination of writing styles (i.e., cursive, print, and mixed) to improve throughput on text entry, as it allows a more natural writing style to be employed versus, for example, engines that require only individual characters requiring a pause between each as it is entered. Preferably, the recognition engine is the QuickPrintPro engine from Motorola, Inc., Lexicus division. The recognition engine typically includes a main dictionary and a user dictionary to which the user may add words to supplement the main dictionary. The recognition engine compares a handwritten input word against all words contained in the main dictionary and the user dictionary. A probability score is generated by the recognition engine for each dictionary word which is indicative of the likelihood that the handwritten word matches that particular dictionary word. Based on each words' probability score, a list of likely matches is collected.

From the recognition results, the handwriting recognition engine calculates a confidence level for the one word (the primary word) with the highest probability. If that confidence level exceeds a preselected or confidence threshold, it is taken as an indication that the word with the highest probability is in fact correct and the highest scoring word is displayed as the primary word choice. All other results are referred to as secondary word choices and may be included in the pop-up list in box 120. So, if the confidence level is above the preselected threshold, the HUI automatically loads a primary word choice into the device's input buffer for delivery to the active application. Otherwise, when the confidence level of the primary word choice is below the confidence threshold, an indication is provided that the recognition engine cannot find a likely candidate, e.g., displaying "???" or something similar into the

device's input buffer. The primary and secondary word choice may be displayed in the pop-up list box 120.

The number of words, n, listed in the pop-up list 120, is user selectable and generally is small enough (5) that the pop up list is contained within the input area

5 104. Providing ready access to word recognition results in the pop-up list increases the likelihood that the correct word is, at the very least, included in the group of top-n words in box 120. Thus, the word recognition rate is generally higher for the group than the overall individual word recognition rate. The word group recognition rate improvement may be as much as 10%. Therefore, presenting the top-n results to the
10 user, where n is typically 5, improves the likelihood that the correct word is displayed, even if the correct word is not the top scoring entry. The correct word may be selected from the group nearly as quickly as accepting a correctly recognized word. Each newly selected word choice is loaded into the system input buffer, and the previously misrecognized word, if any, is deleted from the buffer.

15 Action icons 106, 108, 110, 112, 114 are displayed to provide virtual buttons for editing any previously entered text. Preferably, the icons are displayed together at any side of the input area (e.g., left, right, top or bottom). Editing operations may include, but are not limited to: insert a space 108, backspace 112, delete 114, capitalize recognition result 110, and undo insertion of last recognition result 106.
20 Further, as each word is entered and recognized, a stylus may be used to select one or more characters of the word in a text field of the active application. The preferred recognition engine is also capable of recognizing individual stand-alone characters. At any time, the user can select one (or more) character(s) from a previously entered

word and write a new character(s) in the input area with the result replacing the selected text. Optionally, the editing icon 106 can automatically select a correction keyboard which may be used to edit the last recognition result. When selected, the correction keyboard is displayed in the input area 102.

5 Figure 2 shows an example of the preferred embodiment HUI displaying a word correction keyboard for manually correcting a handwritten word recognition result. In this mode, the user interface displays a QWERTY keyboard 132 in the input area and a word correction window 134. The previously input text is displayed at the top of the screen. Each word is entered and the last recognition result remains
10 displayed for editing in the editing area. As noted above, a single word can be selected or, individual letters within the word may be selected and corrected using the QWERTY keyboard 132. A special purpose key or button 136 may be included in the correction keyboard 132 for inserting the corrected word or substitute word into the user dictionary for inclusion in subsequent recognition.

15 Additional icons (not shown) may be included on the display to allow the user to change selected configuration settings. Configuration settings may include handwriting style preferences and recognition options. Typical recognition options may include an option to propose upper-case at the beginning of a word, an option to suggest end of word punctuation, the number of recognition results displayed in the
20 pop-up list, the location of editing buttons (i.e., left or right hand side of the input area), and user dictionary maintenance, i.e., viewing, adding, and/or deleting entries. The option to propose upper-case may be such that, if set, the recognition engine attempts to recognize the input with and without a leading upper-case letter. The

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option to suggest punctuation also may be included such that the recognition engine may be directed to recognize punctuated handwritten input, automatically discerning when trailing punctuation marks are included. Punctuation mark recognition is simpler in the context of a word. A period, for instance, written by itself is merely
5 meaningless and could be interpreted as anything. However, small digital ink point at the end of a word is much easier to identify and classify as a punctuation mark, e.g. a period, comma, etc.

Handwritten input entry may be provided in unrestricted mixed style that includes cursive (i.e., contiguous characters in each word touching or connected),
10 pure print (i.e., characters in every word disconnected and do not touch), pseudo-print (at most pairs of characters in words touch) or any combination thereof. Thus, for mixed entry, the user is not restricted to cursive, print or pseudo-print inputs. However, to facilitate recognition accuracy and entry speed, the user may designate that entry is to be in one mode only, i.e., cursive, pure print or pseudo print. By thus
15 designating entry mode, the number and complexity of created character alternatives possible may be reduced for the handwriting recognition engine, increasing both recognition accuracy and speed.

Single word-at-a-time input recognition is advantageous over character-at-a-time recognition for text input in these kind of devices, because it enables higher
20 writing throughput when composing messages. Further, single word input in the designated input area is more desirable than writing multiple words or sentences anywhere on the screen, for example, because it is much more structured, simpler to use and, therefore, leads to more predictable and consistent results. Recognition

errors are avoided that could otherwise result from segmenting an input string into words and from corresponding conflicts. These errors and conflicts also result from the inherent ambiguity of inputting with a single pointing device, i.e., a stylus, wherein the stylus is used both as an inking pen for writing and, as a mouse-type pointing device for function selection. For example, the device must distinguish between an inking stroke and scrolling the screen by dragging the stylus. By designating an input area for writing, such conflicts are resolved simply: the stylus functions as an inking pen inside the writing area and as a non-inking pointing device/mouse outside of the input area.

Figure 3 shows a flow diagram of an example of a method 140 for implementing the handwriting user interface of the preferred embodiment of the present invention. First, in step 142 a handwritten word is entered into the designated screen input area. In step 144 a check is made to determine when the handwritten entry is complete; this is typically done with a timer, by pressing a space key or by a special pen gesture. When the handwritten entry is complete, continuing to step 146, the handwriting recognition engine matches the handwritten input against words in the system dictionary as supplemented by the user dictionary. In step 148 a confidence score is attached to the top scoring word. In step 150, the highest scoring words are selected from the dictionaries and displayed in the pop-up list 120.

In step 152 a confidence level for the top scoring word is checked to determine if it exceeds the confidence threshold and so, scores high enough to be accepted as a positive indication of having identified the handwritten word. So, if the confidence level is high enough in step 154, then, it is inserted in the input buffer as primary

word choice for that handwritten word. In step 156 the user is allowed to decide whether the primary word is correct and, if so, returning to step 142, the user can enter a next word. If, in step 152, the confidence level is not high enough, then in step 158, the user is prompted with an indication that the recognition result is less reliable;
5 in the preferred embodiment, this indication is in the form of a special question mark string (“???”) which is inserted in the input buffer, but it could be an audible signal, or any other suitable indication.

In step 160, the pop-up list provided to the user includes the primary word, if any, as the top choice along with the next n-1 highest scoring words so that the user
10 may examine the n highest scoring words. If the correct word is included in the pop-up list, then continuing to step 162, the user can select the correct word. In step 164 that selected word is inserted into the text stream, either to replace the previously provided primary word or as an original word replacing the “???” string and returning to step 142, the user is allowed to enter a next word.

15 However, if in step 160, the correct word is not listed in the pop-up list then, in step 166, the user is allowed to undo the entry. If the user selects to undo the entry, then, in step 168 the previously recognized primary word or the “???” string is removed from the device’s input buffer and so from the display; and, returning to step 142 the user is allowed to enter a next handwritten word. However, if in step 166, the
20 user selects not to undo the previous word, then again returning to step 142, the user can enter a next word. Note that the HUI communicates with the currently active application through the device’s input buffer.

Thus, as can be readily appreciated the HUI of the present invention provides a simple to use, yet elegant handwriting interface for pocket sized devices such as PDAs and the like.

While the invention has been described in terms of preferred embodiments,
5 those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

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